UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/687,098	10/15/2003	Peter-Pike J. Sloan	3382-66130	7230

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EXAMINER
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ART UNIT	PAPER NUMBER
2676	

DATE MAILED: 10/20/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

	Application No.	Applicant(s)
Office Action Summary	10/687,098	SLOAN ET AL.
	Examiner	Art Unit	
	Kevin K. Xu	2676	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE <u>3</u> MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on *15 October 2003*.

2a) ☐ This action is **FINAL**.   2b) ☒ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) *1-11* is/are pending in the application.

    4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5) ☐ Claim(s) _____ is/are allowed.

6) ☒ Claim(s) *1-11* is/are rejected.

7) ☐ Claim(s) _____ is/are objected to.

8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☒ The drawing(s) filed on *15 October 2003* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

    Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

    Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

    a)☐ All b)☐ Some * c)☐ None of:

      1.☐ Certified copies of the priority documents have been received.

      2.☐ Certified copies of the priority documents have been received in Application No. _____.

      3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

    * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 3|25|05

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Drawings

The informal drawings are not of sufficient quality to permit examination. The drawings have "blacked out" regions and thus indistinct areas as observed in Figures 4A, 4B, 4C, 4D, 4E, 7C, 7D, 8B.

Accordingly, replacement drawings sheets in compliance with 37 CFR 1.121(d) are required in reply to this Office action. The replacement sheet(s) should be labeled "Replacement Sheet" in the page head (as per 37 CFR 1.8 (c)) so as not to obstruct any portion of the drawing figures. If the examiner does not accept the changes, the applicant will be notified and informed of any required corrective action in the next Office action.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-2 and 9-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sloan ("Precomputed Radiance Transfer for Real-Time Rendering in Dynamic, Low-Frequency Lighting Environments") in view of Heidrich ("Illuminating Micro Geometry Based on Precomputed Visibility").

In regard to claim 1, Sloan teaches a computer graphics image rendering method, comprising of calculating data of macro-scale radiance transfer coarsely sampled over a surface of an object by showing a novel global transport simulator creates functions over the object's surface representing transfer of arbitrary, low-frequency incident lighting into transferred radiance which includes **global effects** like shadows and interreflections from the object onto itself. (Abstract, lines 4-8) However, Sloan fails to explicitly teach calculating data of meso-scale radiance transfer finely sampled over a meso-structure texture patch mapped over a surface of the object. However, this is what Heidrich teaches. Heidrich teaches an inexpensive method for consistently illuminating height fields and bump maps, as well as simulating BRDFs based on precomputed visibility information, with this information we can achieve a consistent illumination across the **levels of detail**. (Abstract, lines 10-15) Although Sloan does not explicitly teach evaluating radiance transfer over at least a portion of the surface of the object from a lighting environment for a view direction based on a combination of the macro-scale radiance transfer data and the meso-scale radiance transfer data and producing an image of the object as lit according to the radiance transfer evaluation, it would have been obvious to one of ordinary skill in the art at the time the present invention was made to combine the teachings of calculating data of meso-scale radiance transfer sampled over a texture patched mapped over a surface as taught by Heidrich into calculating data of macro scale radiance transfer sampled over a surface taught by Sloan because the computation of meso-scale radiance transfer as taught by Heidrich allows for reduced scattering in the case where curved

base geometry causes the valleys to widen up, and at the same time, more regions are

shadowed (Lower left column of p. 462 and Fig. 11) and allows the use of geometry,

bump maps, and BRDFs as different levels of detail for a surface structure (Right

column of p. 462) and therefore a more accurate 3-D model would be realized.

Regarding Claim 2, Heidrich teaches a computer graphics rendering method

wherein meso-scale radiance transfer data is the height field by explaining the algorithm

is based on precomputation and reuse of visibility information in height fields, simulates

both shadowing and indirect illumination, and is able to approximate the illumination as

underlying base geometry changes. (Lower right column, p. 455) Heidrich further

teaches an algorithm that computes illumination at a given surface point, but ignores

indirect light from geometry other than the height field. (Lower left column, p. 457)

Since claim 2 further limits claim 1 by providing the specific type of data used in meso-

scale radiance transfer, the motivation and combination are incorporated by reference in

the parent rejection.

In regard to claim 9, Sloan teaches a computer-readable data carrying media

having encoded thereon computer executable instructions for performing a computer

graphics image rendering method by explaining graphics hardware useful to capture

radiance samples in a dynamic scene and precision issues and inability to do inner

products in hardware force us to read back the sampled radiance images and project

them in software. (Right column, p.532); said calculating data of **macro-scale** radiance

transfer sampled over a surface of an object by explaining for efficiency, we precompute

textures for the basis functions weighted by differential solid angle, $B1(s) = y1(s)ds(s)$

each evaluated over the cube map parameterization for s. The resulting integral then

becomes a simple dot product of the captured samples of the incident radiance { Lp(s) }

with the textures B1(s). Ideally, this computation would be performed on the graphics

hardware. (Right column, p. 532) Sloan also teaches producing an image of the object

as lit according to the radiance transfer evaluation by showing analysis shows that,

assuming continuous bilinear reconstruction over the sampled 2D images, projection to

6-th order using 6×8×8 images yields 0.7% and 2% average and worst-case squared

error, while 6×16×16 yields 0.2% and 0.5% squared error, and 6×32×32 yields 0.05%

and 0.1% squared error. (Right column, p. 532) However Sloan fails to teach a

computer readable data carrying media having encoded thereon computer-executable

instructions for performing a computer graphics image rendering method, the method

comprising calculating data of **meso-scale** radiance transfer finely sampled over a

meso-structure texture patch mapped over a surface of the object. This is what

Heidrich teaches. Heidrich teaches utilization of graphics hardware for an additional

performance gain, assuming standard OpenGL like graphics pipeline with some

extensions and to implement the pixel texture extension in software. (Right column, p.

458) Furthermore, Heidrich teaches the scattering of light via two points p and q in the

height field first requires us to compute the direct illumination in q. If we do this for all

grid points we obtain a texture Ld containing the reflected light caused by the direct

illumination in each point. This texture Ld is generated using **the bump mapping**

mechanism the hardware provides. Referring to figure 5, the second texture Ld

contains reflected direct light in each point, which acts as an incoming radiance at p.

(Left column, p.459) Although Sloan does not explicitly teach evaluating radiance transfer over at least a portion of the surface of the object from a lighting environment for a view direction based on a combination of macro-scale radiance transfer data and meso-scale radiance transfer data, it would have been obvious to one of ordinary skill in the art at the time the present invention was made to combine the teachings of calculating data of meso-scale radiance transfer sampled over a texture patched mapped over a surface as taught by Heidrich into calculating data of macro scale radiance transfer sampled over a surface taught by Sloan because the computation of meso-scale radiance transfer as taught by Heidrich allows for reduced scattering in the case where curved base geometry causes the valleys to widen up, and at the same time, more regions are shadowed (Lower left column of p. 462 and Fig. 11) and allows the use of geometry, bump maps, and BRDFs as different levels of detail for a surface structure (Right column of p. 462) and therefore a more accurate 3-D model would be realized.

Regarding claim 10, Sloan teaches the computer-readable data carrying media wherein the global effects comprise of self-shadowing and interrelection by showing the resulting precomputed model allows run-time changes to lighting, with correct shadowing and interrelections in any low-frequency lighting environment (Left column of p.533 and Fig. 6) Since claim 10 further limits claim 9 by providing the types of global effects utilized in macro-scale radiance transfer, the motivation and combination are incorporated by reference in the parent rejection.

Claims 3-8 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable

over Sloan ("Precomputed Radiance Transfer for Real-Time Rendering in Dynamic,

Low-Frequency Lighting Environments") in view of Heidrich ("Illuminating Micro

Geometry Based on Precomputed Visibility") in further view of Tong ("Synthesis of

Bidirectional Texture Functions on Arbitrary Surfaces").

Consider claim 3, the teachings of Sloan and Heidrich are given in the previous

paragraphs of this office action. However, both Sloan and Heidrich fail to teach a

computer graphics image rendering method wherein calculating the meso-scale

radiance transfer data comprises of producing a radiance transfer texture encoding

response to incident lighting in a direction and at a location on the meso-structure

texture patch and expressed as a **lighting basis function** and producing a spatial

index map to map the locations on the meso-structure texture patch onto the surface of

the object, via a **precomputed texture synthesis**. Nevertheless, this is what Tong

teaches. Tong teaches real –world textures arise from both spatially variant surface

reflectance and surface mesostructures, which are responsible fro fine-scale shadows,

occlusions and specularities. (Left column of p. 665) Furthermore Tong teaches a

possible way to achieve a consistent mesostructure on a surface is to directly apply

surface texture synthesis techniques to surface BTF synthesis (Left column of p. 666)

and the surface texton space S is the inner-product spanned by using the 3-D textons

{t1….tn} as **basis vectors**. (Left column of p. 667) Although neither Sloan nor Heidrich

explicitly teaches producing a radiance transfer texture expressed as a lighting basis

function and producing spatial index map to map locations on the meso-structure patch

via texture synthesis, it would have been obvious to one of ordinary skill in the art at the

time the present invention was made to combine the teachings of calculating data of

macro-scale radiance transfer coarsely sampled over a surface as taught by Sloan,

calculating data of meso-scale radiance transfer finely sampled over a meso-structure

texture patch as taught by Heidrich and producing radiance transfer expressed as a

lighting basis function and producing spatial index on the meso-structure texture patch

via precomputed texture synthesis as taught by Tong in order to exhibit a consistent

mesostructure when viewing and lighting directions change and to better describe real-

world textures and enable the user to decorate real-world geometry with real-world

textures (Left column of p.672) and accordingly, by incorporating the teachings of Tong

with Sloan and Heidrich, a even more accurate 3-D model would be realized.

Claim 4 is similar in scope to claim 3 and thus is rejected under similar rationale.

Regarding claim 5, Sloan teaches the representation of radiance transfer of the

object's surface sampled at macro-scale is a pre-computed radiance transfer matrix by

showing both incident radiance and transfer functions in a linear basis, we exploit the

linearity of light transport to reduce the light integral to a simple dot product between

their coefficient vectors (diffuse receivers) or a simple linear transform of the lighting

coefficient vector through a small transfer matrix for glossy receivers (Right column of p.

527). Furthermore Sloan teaches if the object is glossy, a transfer matrix is applied to

the lighting coefficients to produce the coefficient of a spherical function representing

self-scattered incident radiance at each point. (left column of p.529). Since claim 5

further limits claim 4 by providing the representation of radiance transfer of the object's

surface if the surface is glossy, the motivation and combination are incorporated by

reference in the parent rejection.

Regarding claim 6, Heidrich teaches the method wherein the representation of

radiance transfer of a meso-structure of the object's surface sampled at meso-scale is a

radiance transfer texture by showing the incoming radiance is not determined by the

intensity of the light source, but rather by the content of the Ld texture. (Left column, p.

458) Since claim 6 further limits claim 4 by providing the representation of meso-scale

radiance transfer being texture, the motivation and combination are incorporated by

reference in the parent rejection.

Consider claim 7, Heidrich teaches the representation of radiance transfer of a

meso-structure of the object's surface sampled at a meso-scale comprises a radiance

transfer texture encoding response at a location on a meso-structure patch in a direction

to incident lighting, and a spatial index map mapping from locations on a the surface of

the modeled object to locations on the meso-structure patch, and wherein the spatial

index map operates as an index to the radiance transfer texture by explaining incident

illumination at any given surface point, and obtaining the reflected radiance for that point

and a given viewing direction (right column of p. 457) and use of the hardware algorithm

to compute higher dimensional data structures, such as light fields [8, 18] and both

space variant and space invariant Bidirectional reflectance distribution functions,

BRDFs. (Right column of p. 461) Since claim 7 further limits claim 4 by providing a

means to map locations on the surface of the modeled object to locations on the meso-

scale patch, the motivation and combination are incorporated by reference in the parent

rejection.

Consider claim 8, Sloan teaches a function of radiance transfer texture

comprising of a view direction to incident lighting by explaining the computing of transfer

field over the object's surface in 3D rather than over a fixed 2D view to allow viewpoint

changes. (Left column of p. 528) Sloan also teaches of a precomputed radiance

transfer matrix encoding radiance response of the location on the surface of the

modeled object to incident lighting L of the light environment by showing the matrix

transforms the lighting coefficients into the coefficients of a spherical function

representing transferred radiance (Fig. 2, p. 528 and equation 9, p. 530) However,

Sloan fails to teach the function of radiance transfer encoding response indexed via an

id map that maps locations on the surface of the modeled object to locations on the

meso-structure patch. This is what Tong teaches. Tong teaches **from the surface**

texton map tout and the sample BTF T, we can efficiently render the BTF on the

target mesh M as follows. First, we compute the viewing and lighting directions for

each mesh vertex v in its local texture coordinate frame from the given light source

location and the viewpoint. Vertices occluded from either the light sources or the

viewpoint are ignored. Then, a set of nearby images are found from the BTF sample T.

Using v's texture coordinate, we can look up colors from this set of images and blend

them to get the color of v. With all vertex colors obtained, the mesh can be sent to the

graphics pipeline for display. This procedure repeats for every novel lighting/viewing

configuration. (Left column of p. 670) Although Sloan does not explicitly teach the

function of radiance transfer texture indexed via an id map that maps locations on the surface of the modeled object to locations on the meso-structure patch, it would be obvious of one of ordinary skill in the art at the time of invention to calculate radiance transfer texture encoding response as taught by Sloan as a function of the mapping of locations on surface of modeled object to locations on the meso-structure patch as taught by Tong in order to efficiently render bidirectional texture function (BTF), which describes textures arising from both spatially variant surface reflectance and surface mesostructures (Abstract, p. 665) and exhibits a consistent mesostructure when viewing and lighting directions change (Left column of p. 672), and thus a more accurate 3-D model would be realized.

Claim 11 is similar in scope to claim 3 except for the addition of a display driver operating to present the image of the modeled object in the lighting environment, which is taught by Heidrich. Heidrich teaches a framebuffer which is read out to main memory, and each pixel is replaced by a value looked up from a texture, using previous contents of the pixel as texture coordinates. (Right column of p. 458) Thus, claim 11 is rejected under similar rationale as claim 3.

Conclusion

Any inquiry concerning this communication or earlier communications from examiner should be directed to Kevin K Xu whose telephone number is 571-272-7747. The examiner can normally be reached on Monday-Friday from 8:30 AM – 5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Bella can be reached on (571) 272-7778.

Information regarding the status of an application may be obtained from Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EB) at 866-217-9197 (toll-free).

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10/05/2005

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